DRIFT COMPENSATION/PARALLEL MINIMIZATION

PRIOR ART

[0001] The present invention relates to a method of recognizing and evaluating motion patterns and pen positions of an electronic pen of the type specified in the preamble of claim **1** as well as to an electronic pen of the type specified in the preamble of claim **9** and a system according to the preamble of claim **10**.

[0002] When movements of an electronic pen are detected by inertial measurement systems, such as acceleration sensors or rotation rate sensors, the data of said sensors have to be integrated once or twice so as to obtain a velocity signal (first integration) or a location signal (second integration) of the electronic pen. Minor errors in the measurement of accelerations and/or angular velocities by means of the inertial measurement sensors of the electronic pen may result in larger velocity determination errors in the case of the first integration, which, in turn, may result in still larger errors in the location signal after the integration of the velocity signal.

[0003] Possible error sources may here comprise not only inherent inaccuracies of numerical integration methods but also, by way of example, inaccuracies of analog-to-digital conversions of measurement sensor signals, zero point errors, e.g. through temperature drift, random interferences or system-inherent noise components.

[0004] Since e.g. a new position of the electronic pen is ascertained starting from a previously ascertained position, errors in the determination of the velocity and the location of the electronic pen may accumulate still further and lead to a so-called drift of the movement signal of the electronic pen in an undesirable manner.

Task

[0005] It is therefore the object of the present invention to improve an electronic pen, especially with respect to the accuracy with which movements of the electronic pen can be detected, and in particular with respect to an improved drift compensation in the movement signal of the electronic pen.

Solution

[0006] According to the present invention, this object is achieved by a method of recognizing and evaluating pen positions of an electronic pen of the type specified in the preamble of claim **1** as well as by an electronic pen of the type specified in the preamble of claim **9** and a system according to the preamble of claim **10**.

[0007] Advantageous embodiments and further developments are the subject matter of the subclaims.

[0008] For detecting the position of the tip or writing rod tip of an electronic pen, said pen can be provided with inertial measurement sensors, and the movement can be reconstructed by integrating the measurement data of these sensors.

[0009] A method according to the present invention for recognizing and evaluating movement patterns and pen positions of an electronic pen with inertial measurement sensors during writing on a two-dimensional writing substrate may here comprise the following steps:

[0010] initially specifying two axes X, Y, which are orthogonal to each other, on the writing substrate and an axis Z perpendicular to the two-dimensional writing substrate, the X axis defining e.g. a writing direction or the predominant writing direction. The axes X, Y, Z can thus define a reference coordinate system for the electronic pen.

[0011] Said initial specification of two axes, which are orthogonal to each other on the writing substrate, e.g. of said X axis and said Y axis, can be carried out as a function of the elevation angle or inclination angle γ of the longitudinal axis of the electronic pen with respect to the writing substrate and/or as a function of an azimuthal angle ϵ of the longitudinal axis of the electronic pen or of a projection of the longitudinal axis of the electronic pen.

[0012] Hence, the axes X, Y can define the writing substrate plane, and positions in the writing substrate plane can be described with the writing substrate coordinates x, y.

[0013] Furthermore, said method according to the present invention may comprise a compensation of an undesirable drift in the pen position signal of the electronic pen to be output, comprising the following steps:

[0014] executing in parallel a coordinate transformation of the azimuthal angle ϵ and of the inclination angle γ of the electronic pen into writing substrate coordinates x, y for the values of the azimuthal angle ϵ and of the inclination angle γ determined from the inertial measurement sensors as well as for a plurality of additional predeterminable values of the azimuthal angle ϵ and the inclination angle γ, which, e.g. in predetermined intervals of values, may lie around the values of the azimuthal angle ϵ and of the inclination angle γ determined from the inertial measurement sensors, comprising determining the optimum linear combination of the values of the azimuthal angle ϵ and of the inclination angle γ at which a minimum deviation of an ascertained acceleration of the electronic pen in the Z direction from a predetermined, expected acceleration in the Z direction is achieved, and selecting the determined values of the azimuthal angle ϵ and of the inclination angle γ, which result in a minimum deviation of an ascertained acceleration of the electronic pen in the Z direction from a predetermined, expected acceleration in the Z direction, for correcting a pen position signal to be output, e.g. in particular an acceleration signal of the electronic pen to be output.

[0015] In this context it should be pointed out that the term pen position signal may comprise location signals as well as movement and acceleration signals of the electronic pen. Furthermore, the term inertial measurement sensors stands hereinbelow for a plurality of inertial sensors of the electronic pen, which are capable of measuring in three spatial directions, which are orthogonal to one another, accelerations and/or the strength of the local magnetic field and/or rotation rates, in particular the spatial position angle of the electronic pen, e.g. the azimuthal angle ϵ and the inclination angle γ.

[0016] A linear combination of values of the azimuthal angle ϵ and of the inclination angle γ may here stand for a pair of values comprising a respective value of the azimuthal angle ϵ and a respective value of the inclination angle γ.

[0017] It follows that, advantageously and preferentially, the values for the azimuthal angle ϵ and the inclination angle γ can be optimized in common so as to find the optimum pair of values for the azimuthal angle ϵ and the inclination angle γ in the case of which a minimum deviation of an ascertained acceleration of the electronic pen in the Z direction from a